INFLUENCE OF GLEN CANYON DAM OPERATIONS ON DOWNSTREAM SAND RESOURCES OF THE COLORADO RIVER IN GRAND CANYON

Scott A. Wright, Theodore S. Melis, David J. Topping, and David M. Rubin

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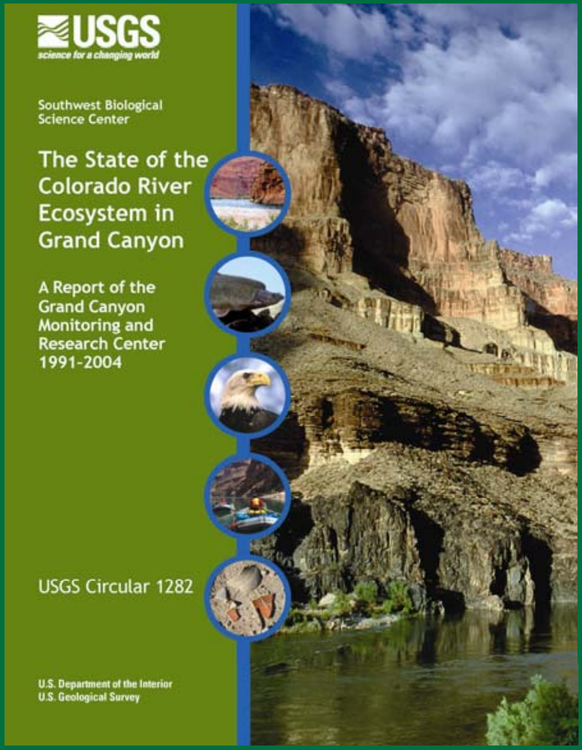
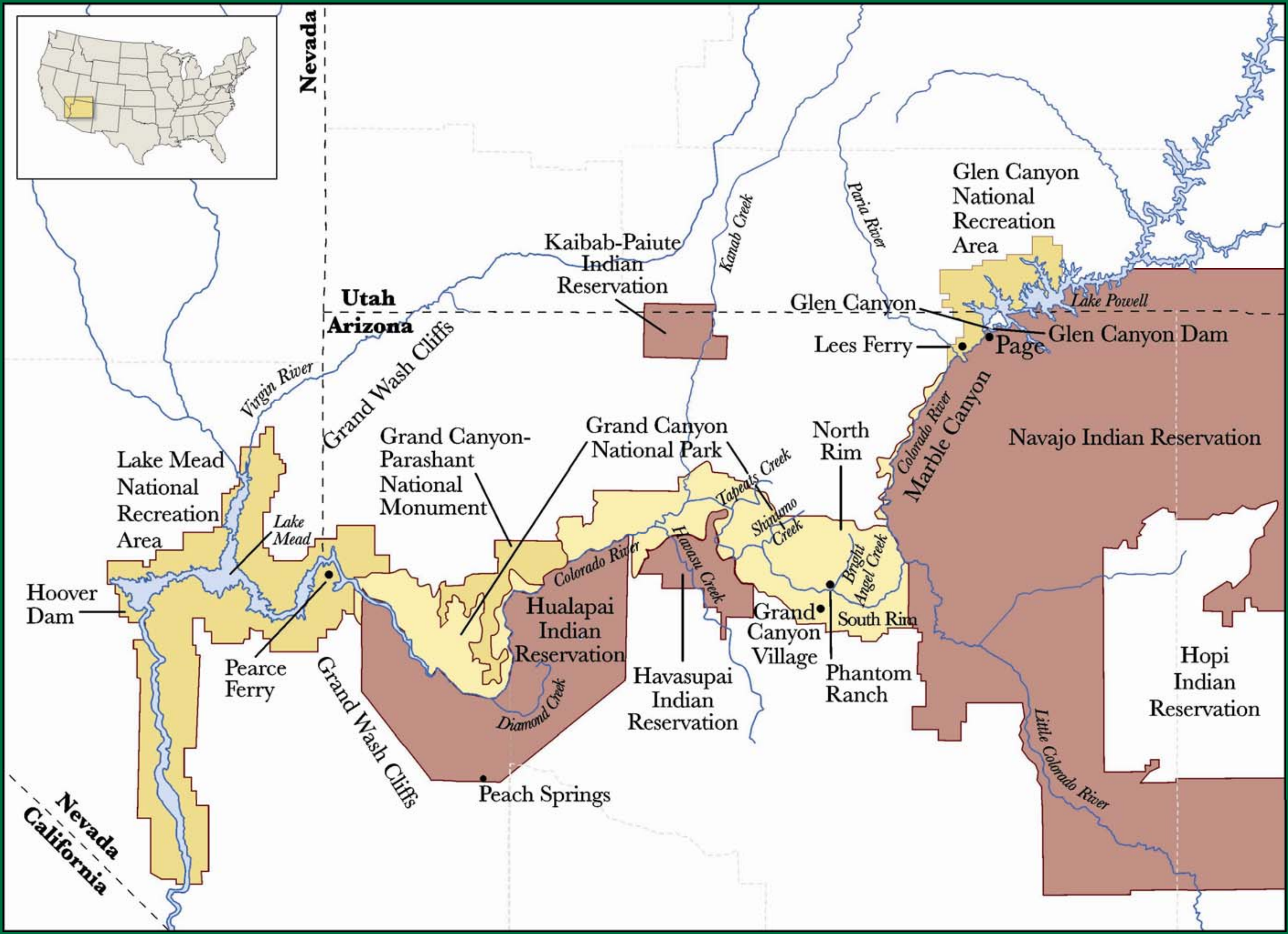


U.S. Department of the Interior
U.S. Geological Survey

Geographic Orientation



Colorado River Flow "Eras"

- Pre-dam: annual snowmelt floods ~ 100,000 cfs; significant seasonal variation
- 1963 – 1991: daily fluctuations from < 5,000 cfs to powerplant capacity (~32,000 cfs) – power generation
- 1991 – 1996: Interim Operating Criteria – reduced allowable daily fluctuations – environmental concerns
- 1996 – present: Modified Low Fluctuating Flows (MLFF) – EIS preferred alternative – similar to Interim Operations – Record-of-Decision (ROD) in 1996

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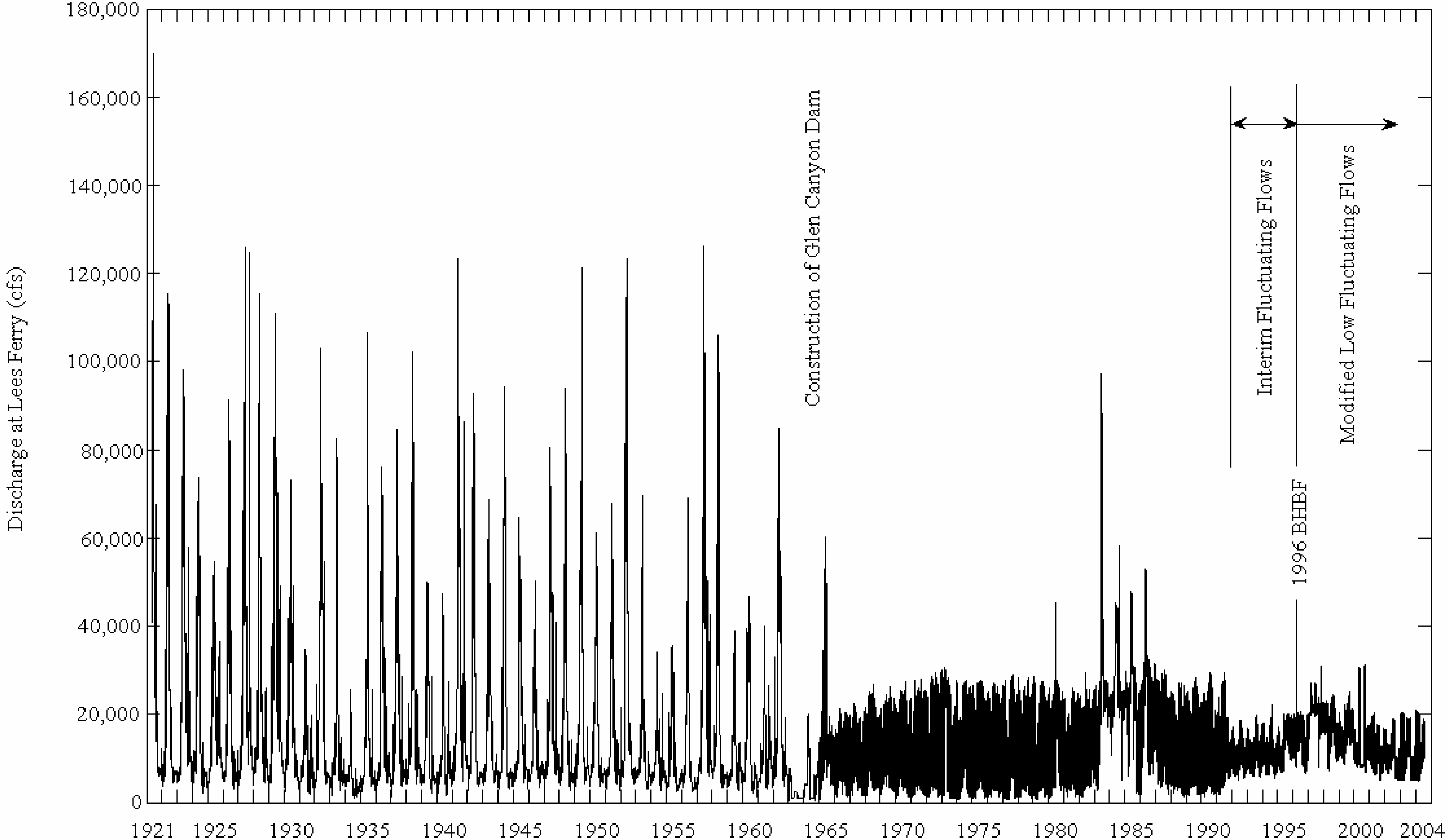

From Topping and others, 2003

Presentation Outline

- Description of Grand Canyon sandbars
- Geomorphic effects of dams (Glen Canyon)
- Review of the EIS conclusions for sandbar response to MLFF
- Evaluation of EIS conclusions using data collected since implementation of MLFF
- The role of science in adaptive management – experimental high-flow of November 2004

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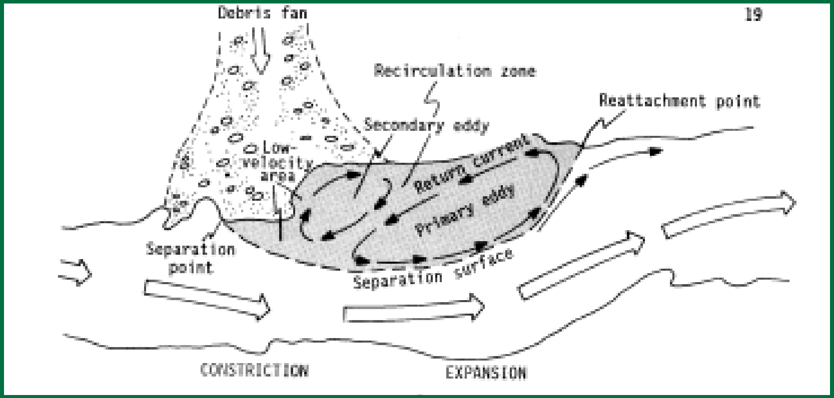
Grand Canyon Sandbars

Formed by deposition in recirculating eddies downstream from debris fans



From Schmidt and Graf, 1990

Used by river runners as campsites

Create low velocity areas – fish habitat

Substrate for riparian vegetation

Protect archaeological resources

Geomorphic Effects of Dams

- Reservoir traps most incoming sediment - reduced supply to downstream reaches
- Dam regulates flow, smaller peaks – reduces transport capacity of downstream reaches

Two possibilities for a downstream reach :

1) Tributary inputs > transport capacity: sediment surplus = accumulation
2) Transport capacity > tributary inputs: sediment deficit = erosion

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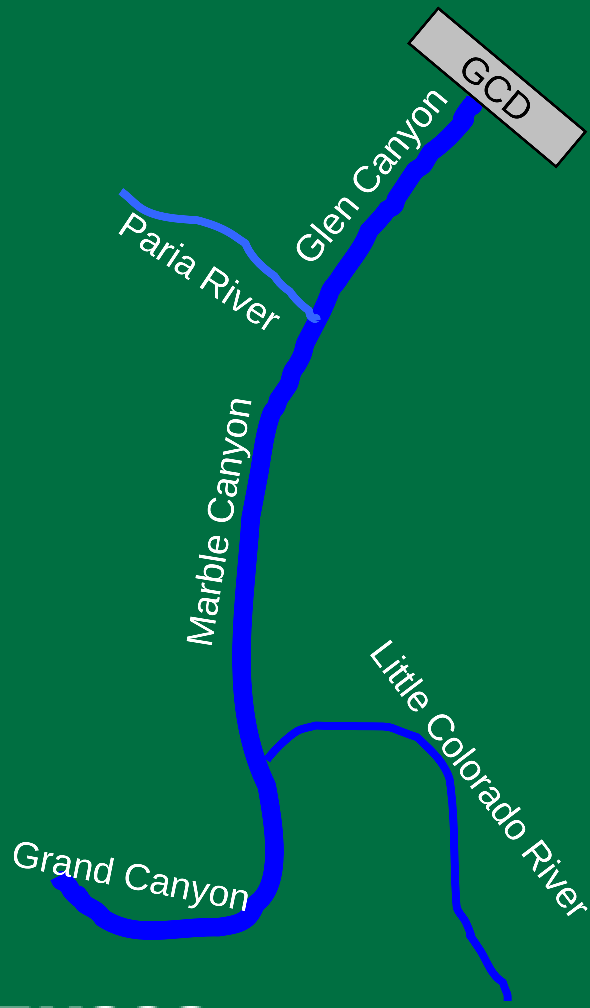
Geomorphic Effects of Glen Canyon Dam



Few tributary inputs to Glen Canyon – erosion of 2-3 m

Paria River: ~6% of pre-dam sand supply to Marble Canyon

Paria + LCR: ~16% of pre-dam sand supply to Grand Canyon

Has the transport capacity been reduced more than the supply?

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EIS Conclusions Related to Sandbars

1. Below Lees Ferry, sand inputs exceed sand transport capacity. Sand should accumulate in the channel in Marble and Grand Canyons over multiple years.

2. Sand that accumulates in the channel over multiple years can be transferred to sandbars using high-flow dam releases.

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EIS Multi-Year Accumulation Conclusion

Accumulation during low to moderate release years.

Erosion during wet periods.

Net accumulation over the long-term.

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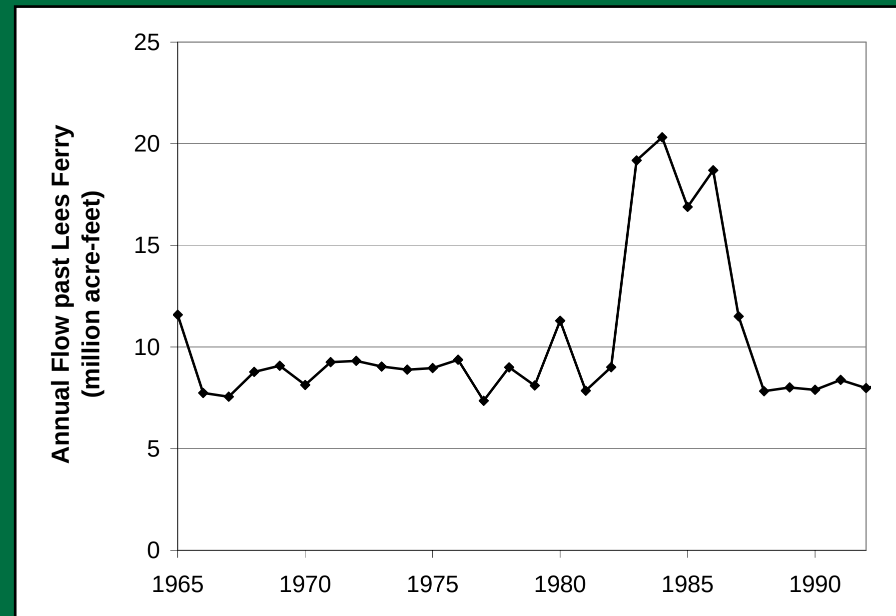
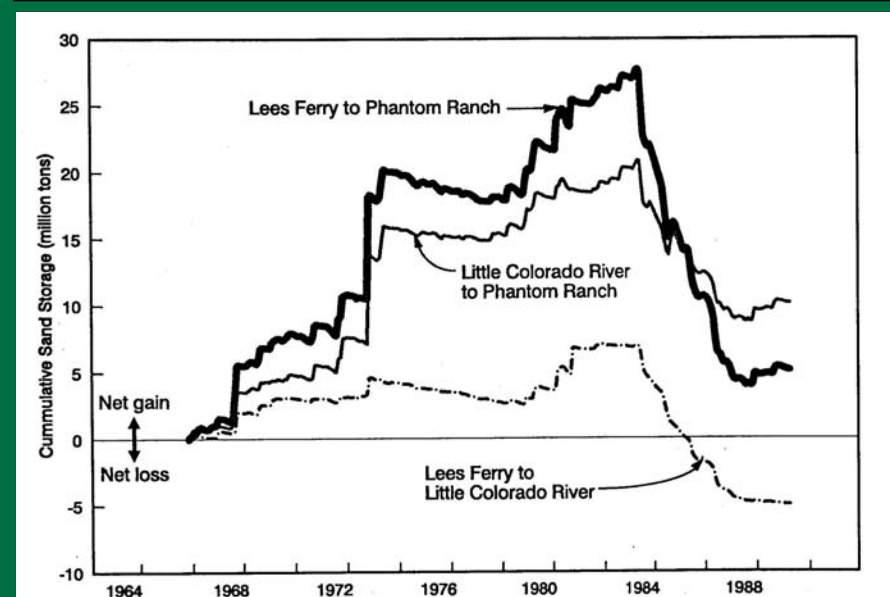


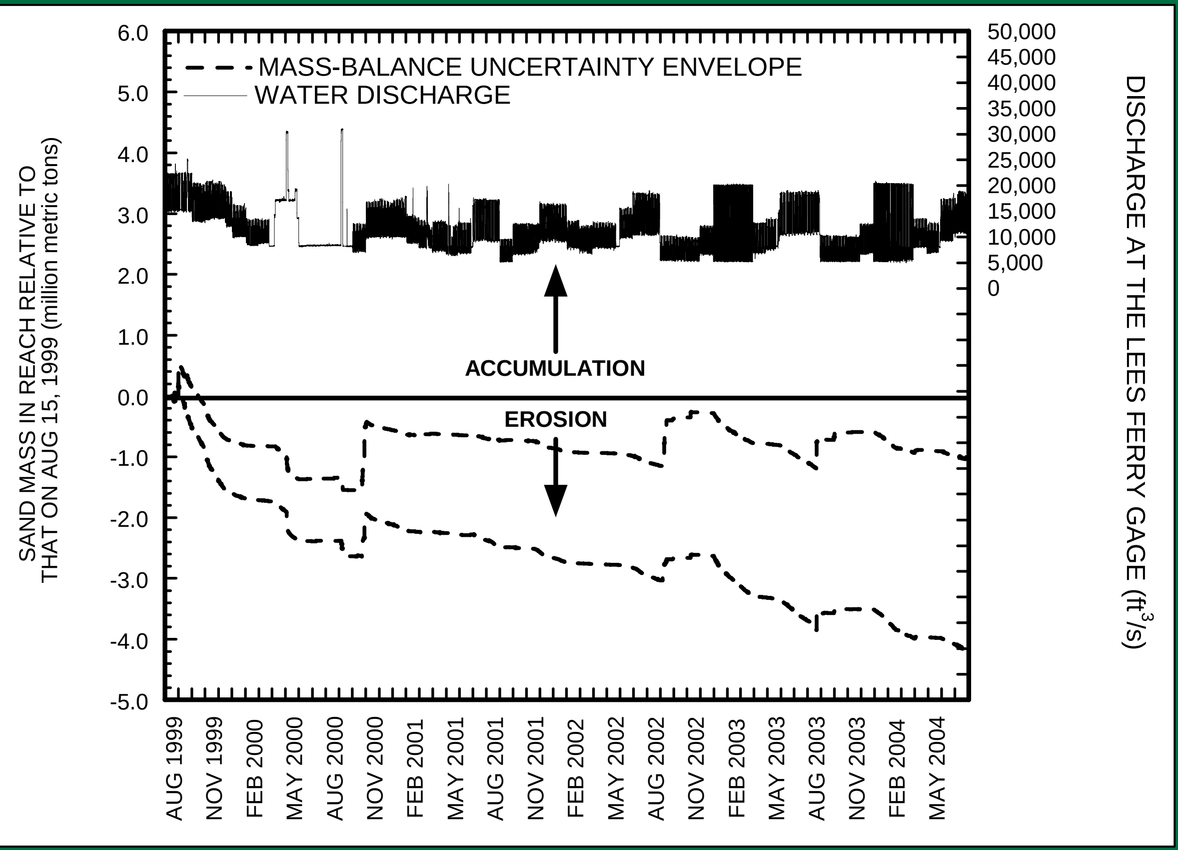


From U.S. Dept. of Interior, Bureau of Reclamation, 1995

Evaluation of the EIS Conclusions

Several recent research and monitoring findings do not support the EIS conclusions

Evaluation of the EIS Conclusions



Courtesy of David J. Topping, USGS National Research Program
Detailed description of methods on Thursday at 11:55

Detailed measurements of sand inputs and transport indicate erosion between Lees Ferry and Phantom Ranch from 1999-2004.

Tributary inputs are exported from the reach in weeks to months.

Releases were low during drought hydrology – EIS predicts accumulation (more detail Thursday 12:15)

Evaluation of the EIS Conclusions

Repeat surveys of channel cross-sections between Lees Ferry and Phantom Ranch indicated erosion at 55 of the 57 sites from 1992 to 1999.

Flynn and Hornewer 2003

http://permanent.access.gpo.gov/waterusgsgov/water.usgs.gov/pubs/wri/wri034104/pdf/wrir03-4104.pdf

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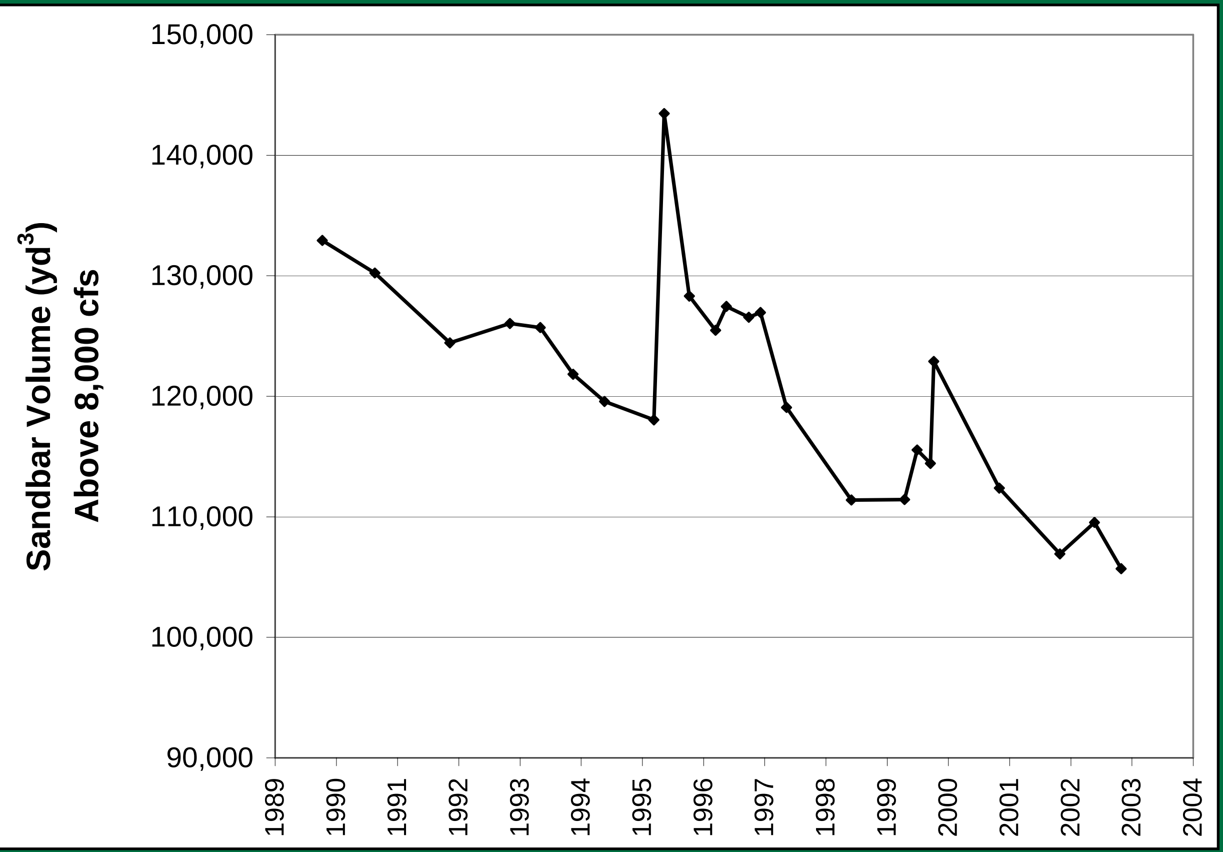
Evaluation of the EIS Conclusions



Courtesy of Northern Arizona University Geology Department

Repeat surveys of 14 sandbars between Lees Ferry and Phantom Ranch show ~20% decreases in area and volume from 1990 to 2003.

Evaluation of the EIS Conclusions

Topographic Storage Components	1996 Controlled Flood,[a] m
High-Elevation Eddy	0.18 ± 0.05
Low-Elevation Eddy	-0.56 ± 0.18
Channel Margin	0.30 ± 0.10
Main-channel bed	-0.49 ± 0.13

From Hazel and others, in press

1996 BHBF built high-elevation bars, but more sand came from lower portions of eddies than from the channel.

Net loss of sand from eddies occurred in 1996 – not sustainable.

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Evaluation of the EIS Conclusions

1. Not supported - Sand does not accumulate in the channel over multiple years, even during minimum release years under MLFF. Rather, tributary inputs are rapidly exported leading to a sand deficit condition and sandbar erosion.

2. Partially supported – High flows can transfer sand to high-elevation portions of bars, but in 1996 most of the sand came from low elevation bars instead of the channel and there was net loss of sand from eddies.

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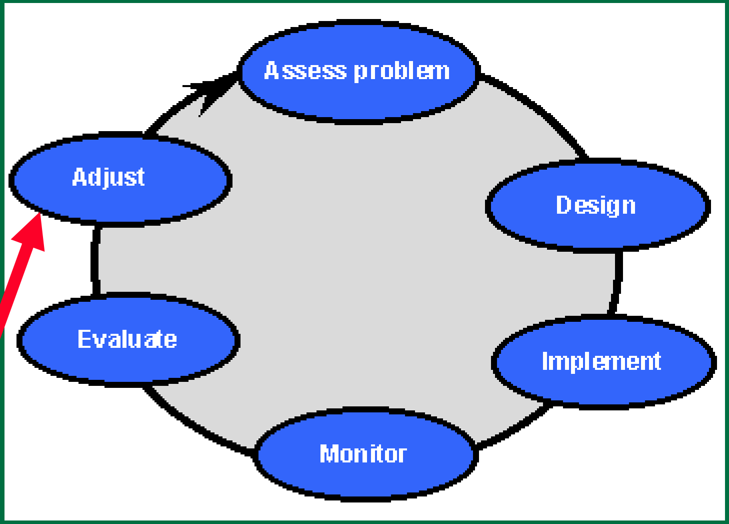
Science and Adaptive Management

Based on these new findings, scientists in 2002 recommended two experimental approaches:

1) Conduct high-flow experiment immediately following tributary inputs

2) Follow tributary inputs with low dam releases until high-flow experiment can be conducted



High-flow experiment triggering criteria were established based on tributary input levels

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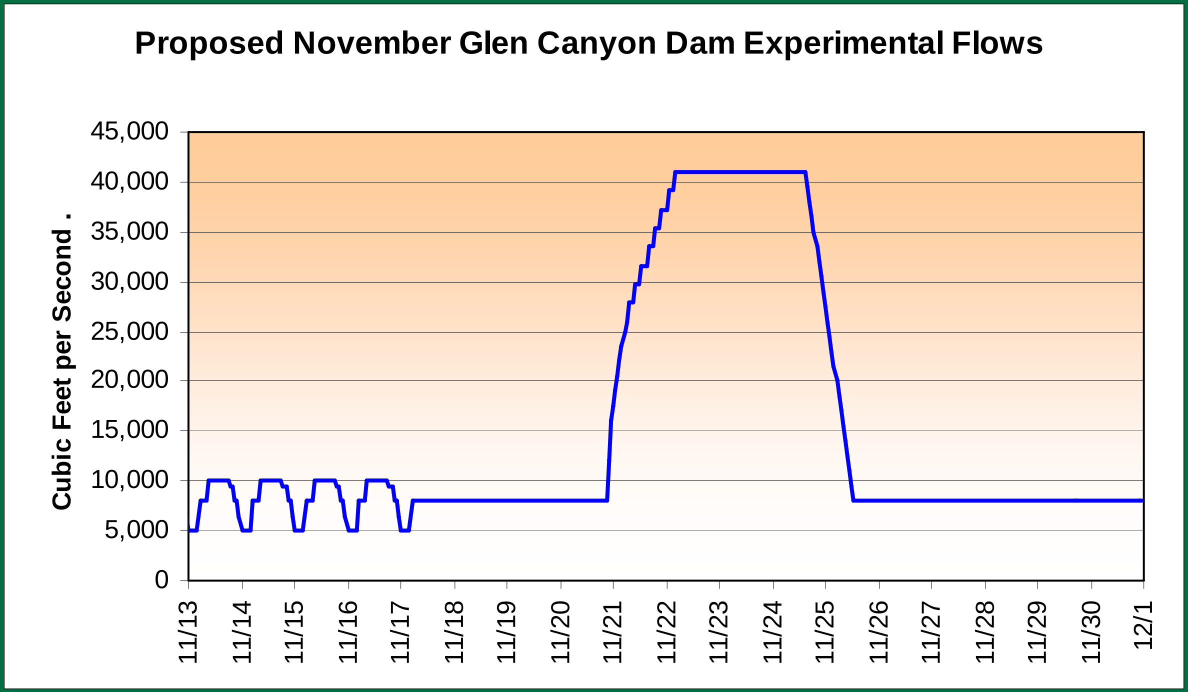
Science and Adaptive Management

In Fall 2004, tributary input triggering criteria were met, resulting in an experimental high-flow release

Results presented Wednesday from 8:40 – 10:00



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Future Research Questions

- Can high-flow releases timed to coincide with tributary inputs reverse the trend of sandbar erosion under MLFF operations?
- What is the optimum strategy, in terms of high-flow release frequency and hydrograph shape, for managing limited sand supplies? Modeling – Wiele talk at 11:35 Thursday
- If this strategy is not effective, what other alternatives (e.g. further constrained dam releases, sediment augmentation) would be more effective?

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Thank You!